B. E.

Seventh Semester Examination, May-2009

AUTOMOBILE ENGINEERING

Note : Attempt any five questions. All questions carry equal marks.

Q. 1. (a) Enumerate different types of frames. Compare their merits and demerits.

Ans. Frame :

There are two distinct forms of construction in common use :

1. The conventional pressed steel frame to which all the mechanical units are attached and on which the body is superimposed.
2. The integral or frameless construction, in which the body structure is designed as to combine the functions of body and frame the units normally attached to the frame then being attached directly to the body.

The frameless construction is, however, possible only in the case of a closed car, since the roof, screen pillars, door pillars and rear panel are essential load-taking parts of the structure.

The frameless construction has the following advantages over the conventional framed construction :

(i) Reduced weight and consequent saving in fuel consumption.

(ii) Lower manufacturing cost.

(iii) During collision the body crumbles, thereby absorbing the shock due to impact and thus providing safety to the passengers.

(iv) Compared to framed construction lower body position may be obtained, thus resulting in increased stability of the automobile.

However these advantages are accompanied by the following disadvantages also :

(i) Reduction of strength and durability.

(ii) Economical only if frameless construction is adopted in mass production.

(iii) Increased cost of repairs in case of damage to body during accidents.

(iv) Topless cars are difficult to design with the frameless construction.

Apart from above two types of construction, a compromise has also been adopted in many cases (e.g. Volkswagen, Germany), which incorporates features of both of these types. In this a pressed steel floor, suitably strengthened by some longitudinal and cross members, including the central longitudinal steel tube, called 'backbone' is used.

Q. 1. (b) Discuss the advantages and disadvantages of front wheel drives vehicles over rear wheel drive vehicles.

Ans. While taking turns, the driving wheels must turn at different speeds. This is done with the help of differential.

Instead of using the long propeller shafts and transmitting the power from engine to the rear axle, a number of alternative methods have been used :

1. The engine power is transmitted to the front axle which is nearer the engine (Fig. 5). The advantages of this system are :

(i) The propeller shaft is eliminated and the linkage for clutch and the transmission is simplified. This permits a low chassis height.

(ii) The engine pulls the car rather than pushing it, avoiding skidding tendency, thus providing safety, especially on snow-covered roads.

(iii) Better road adhesion is obtained in this case because larger part of the weight of the automobile is taken on the driving wheels.

(iv) This arrangement tends to produce understeering characteristics which is preferred over over steering condition.

2. The above advantages are, however, accompanied by the following disadvantages :

(i) The front wheels which are in this case the driving wheels, have to be steered also, which make the whole arrangement complicated.

(ii) Two constant velocity joints have to be used in this case, because ordinary universal joints would give large speed fluctuations.

(iii) Also the component of the automobile weight on the driving wheels is reduced when going up steep gradients. This results in decrease of tractive effort when it is needed most.

(iv) Moreover, on level roads increased concentration of weight of weight at the front tends to make the steering slightly heavier.

Q. 2. Describe various requirements of automotive clutch. Discuss in detail the construction and working of a centrifugal clutch.

Ans. Requirements of Clutch :

(i) Torque Transmission:

The clutch-should be able to transmit the maximum torque of the engine under all conditions. It is usually designed to transmit 125 to 150 percent of the maximum engine torque. As the clutch slips during engagement, the clutch facing is heated. Clutch temperature is the major factor limiting the clutch capacity. This requires that the clutch facing must maintain a reasonable coefficient of friction with the mating surfaces under all working conditions. Moreover the friction material should not crush at high temperatures and clamping loads.

2. Gradual Engagement :

The clutch should positively take the drive gradually without the occurrence of sudden jerks.

3. Heat Dissipation :

During clutch application, large amounts of heat are generated. The rubbing surfaces should have sufficient area and mass to absorb the heat generated. The proper design of the clutch should ensure proper ventilation or cooling for adequate dissipation of the heat.

4. Dynamic Balancing :

This is necessary particularly in the high speed clutches.

5. Vibration Damping :

Suitable mechanism should be incorporated with the clutch, to eliminate noise produced in the transmission.

6. Size :

The size of the clutch must be smallest possible so that it should occupy minimum amount of space.

7. Inertia :

The clutch rotating parts should have minimum intertia. Otherwise, when the clutch is released for gear changing, the clutch plate will keep on spinning, causing hard shifting and gear clashing in spite of synchronizer.

8 Clutch Free Pedal Play :

To reduce effective clamping load on the carbon thrust bearing and wear thereof, sufficient clutch free pedal play must be provided in the clutch.

9. Ease of Operation :

For higher torque transmissions the operation of disengaging the clutch must not be tiresome to the driver.

Centrifugal Clutch :

In the fully centrifugal type of clutches, the springs are eliminated altogether and only the centrifugal force is used to apply the required pressure for keeping the clutch in engaged position.

The advantage of the/centrifugal clutch is that no separate clutch pedal is required. The clutch is operated automatically depending upon the engine speed. This means that car can be stopped in gear without stalling the engine. Similarly while starting, the driver can first select the gear put the car into the gear and simply press the accelerator pedal. This makes the driving operation very easy.

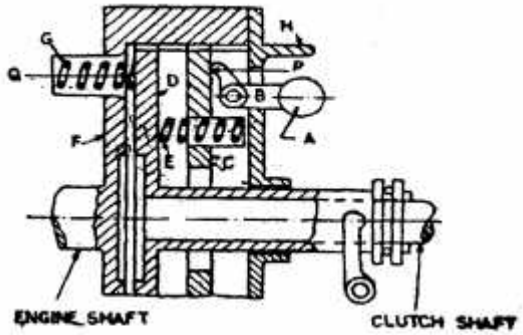
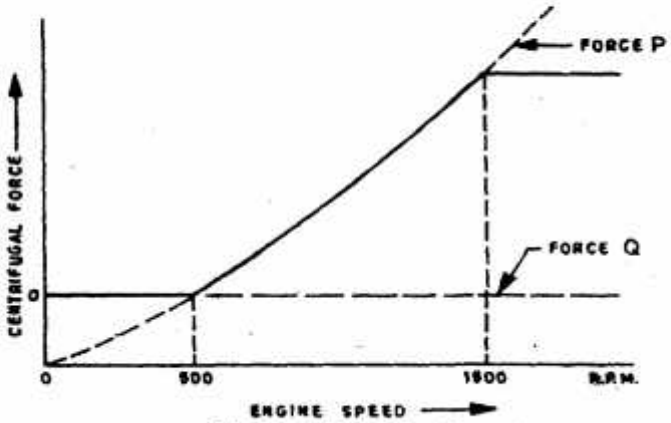


Fig. Principle of Centrifugal Clutch

Fig. shows a schematic diagram of a centrifugal clutch. As the speed increases, the weight A flies, thereby operating the bell crank lever B which presses the plate C. This force is transmitted to the plate D by means of springs E. The plate D containing friction lining is thus pressed against the flywheel F thereby engaging the clutch.

Spring G serves to keep the clutch disengaged at low speed, say, 500 rpm. The stop H limits the amount of centrifugal force.

The operating characteristics of this type of clutch will be then as shown in fig.



Characteristics of Centrifugal Clutch.

Force P is proportional to the centrifugal force at a particular speed, while force Q exerted by spring G is constant at all speeds. The firm line in the figure shows the net force on the plate D for various engine speeds. At the upper end the curve is made flat by means of stop H.

Q. 3. Sketch the layout, explain the construction and working of synchromesh gear box used on any Indian vehicle.

Ans. Synchromesh Gear Box :

This type of gear box is similar to the constant mesh type in that all the gears on the mainshaft are in constant mesh with the corresponding gears on the layshaft. The gear on the layshaft are fixed to ti while those on the mainshaft are free to rotate on–the same. Its working is also similar to the constant mesh type, but in the former there is one definite improvement over the latter. This is the provision of synchromesh device which avoids the necessity of double declutching. The parts which ultimately are to be engaged, are first brought into frictional contact which equalizes their speed, after which these may be engaged smoothly.

Fig. shows the construction and working or a synchromesh gear box. In most of the cars, however, the synchromesh devices are not fitted to all the gears as is shown in this figure. They are fitted only the high gears and on the low and reverse gears ordinary dog clutches are only provided, this is done to reduce the cost.

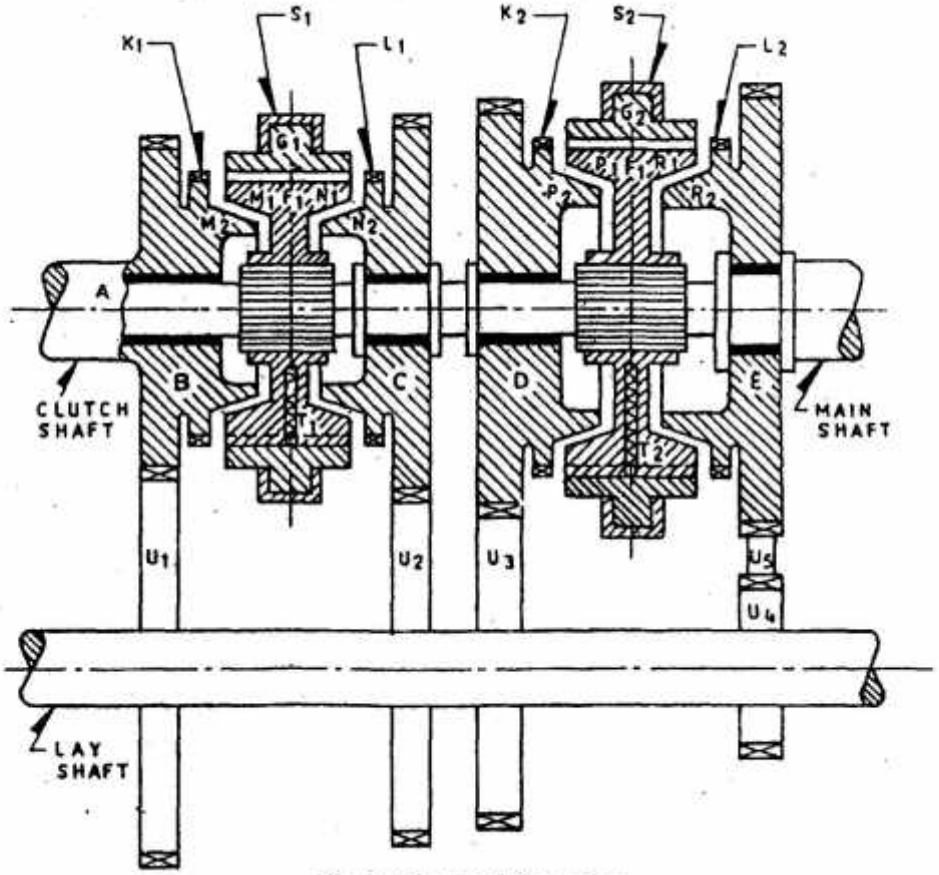


Fig. Synchromesh Gear Box

In fig. A is the engine shaft, Gears B, C, D, E are free on the main shaft and are always in mesh with corresponding gears on the layshaft. Thus, all the gears on mainshaft as well as on layshaft continue to rotate so long as shaft A is rotating. Members F_1 and F_2 are free to slide on splines on the mainshaft. G_1 and G_2 are ring shaped members having internal teeth fit onto the external teeth members F_1 and F_2 respectively. K_1 and K_2 are dog teeth on B and D respectively and these also fit onto the teeth of G_1 and G_2. S_1 and S_2 are the forks. T_1 and T_2 are the balls supported by springs. These tend to prevent the sliding of members $G_1(G_2)$ on $F_1(F_2)$. However, when the force applied on $G_1(G_2)$ through fork $S_1(S_2)$ exceeds a certain value, the balls are overcome and member $G_1(G_2)$ slides over $F_1(F_2)$. There are usually six of these balls symmetrically placed circumstantially in one synchromesh device. M_1, M_2, N_1, N_2, P_1, P_2, R_1, R_2 are the frictional surfaces.

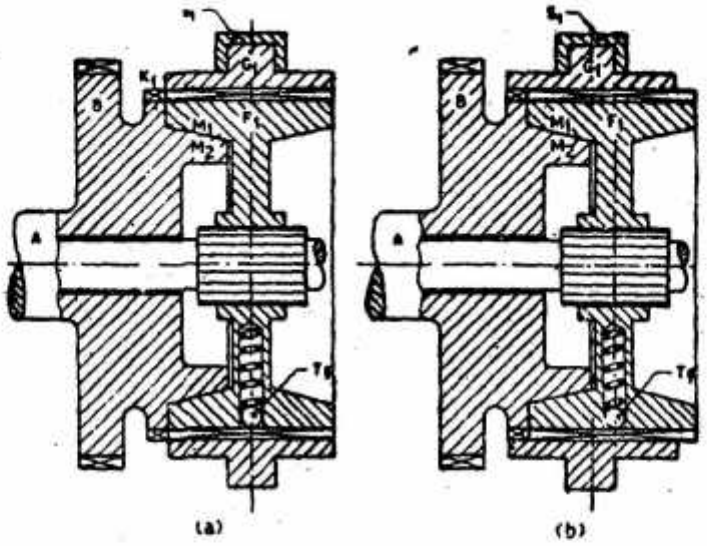


Fig. Engagement of direct gear in a synchromesh gear box

To understand the working of this gear box, consider Fig. which shows in steps how the gears are engaged. For direct gear, member G_1 and hence member F_1 (through spring-loaded balls) is slid towards left till cones M_1 and M_2 rub and friction makes their speed equal [Fig. (a)]. Further pushing the member P_1 to left causes it to override the balls and get engaged with dogs K_1 [Fig. (b)]. Now the drive to the mainshaft is direct from B via F_1 and the splines. However, if member G_1 is pushed too quickly so that there is not sufficient time

for synchronization of speeds, a clash may result. Likewise defect will arise in case springs supporting the balls T F hive become weak.

Similarly for second gear the members F_1 and G_1 are slid to the right so that finally the internal teeth on G_1 are engaged with L_1. Then the drive to mainshaft will be from B via U_1, U_2, C, F_1 and splines.

For first gear, G_2 and F_2 are moved towards left. The drive will be from B via U_1, U_3, D, F_2 and splines to the main shaft.

For reverse, G_2 and F_2 are slid towards right. In this case the drive will be from B via, U_1, U_4, E, F_2 and splines to the main shaft.

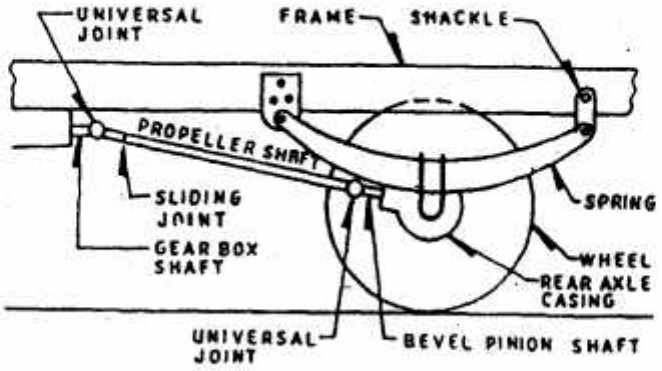
In this type of gear box it is very necessary for the smooth operation that sufficient time is allowed for the equalisation of the speeds before the gears are finally brought into mesh. To help in this special modifications have been employed in many gear boxes. One such modified synchromesh device is shown in Fig. A synchroniser ring is provided between the dog teeth K_1 and member F_1. To push this synchroniser ring in the desired direction, three guide bars equally spaced along the circumference are provided. These are retained in place by means of circlips. The synchroniser ring has dog teeth at its outer circumference and is cut at three places to provide space for the guide bars. The width of each cut is equal to the width of the guide bar plus half the pitch of the teeth on the synchroniser ring.

Q. 4. (a) Describe clearly the constructional details and operation of various rear axle drives with the engine placed at the front. Illustrate your answer with simple and neat sketches.

Ans. Rear Axle Drives

In all the drives employed for the rear axle the springs take the weight of the body. Many drives are used, out of which the two important ones are the Hotchkiss drive and the Torque-tube drive.

Hotchkiss Drive :



This is the simplest an most widely used type of rear axle drive. In this case the springs besides taking weight of the body, also take the torque reaction, driving thrust and the side thrust. Fig. shows such a drive. The propeller shaft is provided with two universal joints and also a sliding joint. The spring is fixed rigidly in the

middle, to the rear axle. The front end of the spring is fixed rigidly. on the frame, while the rear end is supported in a shackle. The driving thrust is transmitted to the frame by the front half of the springs.

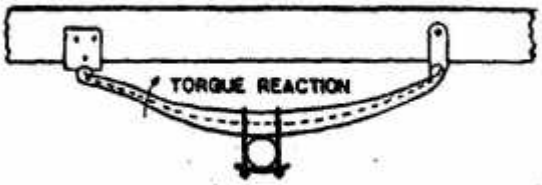


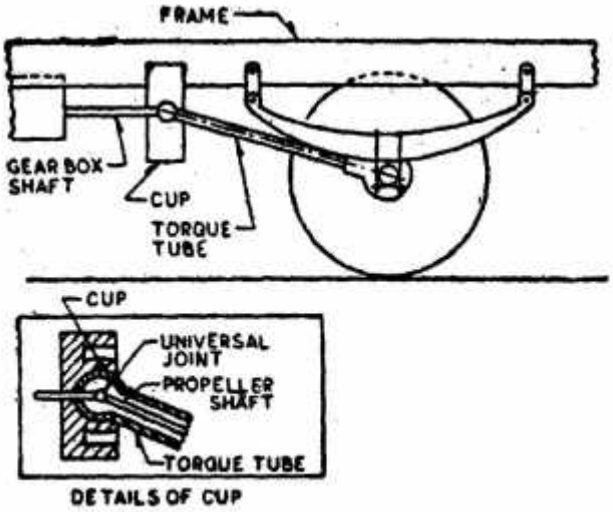
Fig. Bending of spring under torque reaction

Due to the torque reaction, the spring deflects as shown in fig. Thus, torque reaction is taken up by the springs. Similarly, to take up the braking torque the springs would deflect in the opposite direction. When the springs deflect in the manner shown, the bevel pinion shaft also changes its position.

Therefore if there is only one universal joint at the front end of the propeller shaft, it will bend under this condition. To avoid this, another universal joint at the rear end of the propeller shaft is used.

Again when the rear axle moves up and down, it has to move in a circle with the front spring support at the frame as centre. But for the propeller shaft motion, the centre is at the front universal joint. This means that during this movement of the rear axle, the length of the propeller shaft has to vary. This is provided for by means of a sliding joint in the propeller shaft.

Torque Tube Drive :

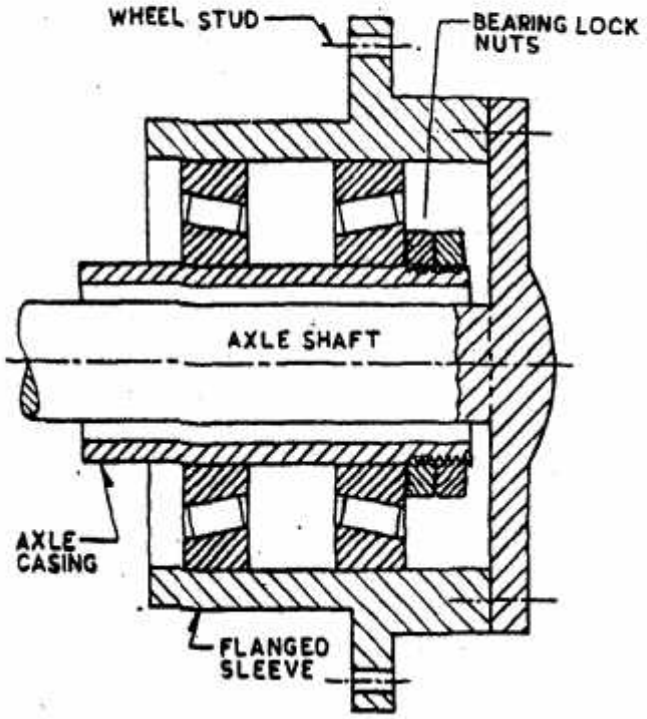


In this type of drive, the spring takes only the side thrust besides supporting the body weight. The torque reaction, braking torque and the driving thrust are taken by another member which is called the torque tube. One end of torque tube is attached to the axle casing, while the other end which is spherical in shape fits in the cup fixed to the frame as shown in fig. As is seen the torque tube encloses the propeller shaft. Since in this case the torque tube takes the torque reaction, the centre line of the bevel pinion shaft will not shift and further it will always pass through the centre of the spherical cup if the propeller shaft is connected to the gear box shaft by means of a universal joint situated exactly at the centre of the spherical cup. In such a situation, no universal joint is needed at the rear end of the propeller shaft. Also no sliding joint is provided because both the pinion shaft and the propeller shaft in this case will move about the same centre, i.e., about the centre of the spherical cup. Clearly torque reaction and the driving thrust are taken by the torque tube

Note : In both the types of drives the side thrust is taken by the leaf springs. If, however, coil springs are used, they are not able to take side loads and therefore, a separate member is employed in that case. Such a member is usually in the form of a transverse radius rod fixed approximately parallel to wheel axis, with one end pivoted to the axle casing and the other to the chassis frame. Such rods are usually called Panhard rods Fig.

Q. 4. (b) Discuss the constructional features of a fully floating axle with the help of a sketch.

Ans. Full-Floating Axle :



This type is very robust one and is used for heavy vehicles. As is seen in Fig. the axle shafts have flanges at the outer ends, which are connected to the flanged sleeve by means of bolts. There are two taper roller bearings supporting the axle casing in the hub, which take up any side load. Thus in this the axle shafts carry only the driving torque. The weight of the vehicle and the end thrust are not carried by them, the weight being completely supported by the wheels and the axle casing. As the axle shafts carry only the driving torque, their failure or removal does not affect the wheels. Thus the axle shafts can be taken out or replaced without jacking up the vehicle. For the same reason the vehicle can be towed even with a broken half-shaft. However, it is the costliest type.

Q. 5. Differentiate clearly between the functions of a spring and a shock absorber. Explain the construction and working of a telescopic type of shock absorber with the help of neat diagram.

Ans. Rubber springs

The advantages of using rubber as a means of suspension are :

1. It can store greater energy per unit weight than the steel. For this reason rubber springing system can be made more compact.
2. The rubber has excellent vibration damping properties.
3. The absence of squeaking which is always present in steel springs.
4. The number of bearings is reduced considerably for the rubber suspension system. This means longer life.
5. Rubber is more reliable. A rubber suspension cannot suddenly fail like the metal springs.

The various types of rubber springs used for vehicles are discussed below :

1. Compression spring :

This type of spring is still being used because of the following advantages :

(i) It is reliable, of simple construction and requires no bonding.

(ii) It provides a rising rate characteristic.

(iii) It can resist occasional overload of large magnitude.

(iv) It has a large measure of inherent damping than most types of rubber springs.

However, its use is limited because of the fact that some mechanical guide must be provided with this type of spring, and the provision of mechanical guide is generally undesirable.

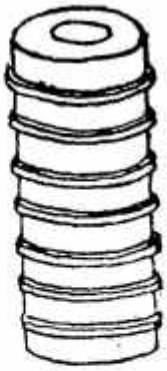


Fig. Compression spring

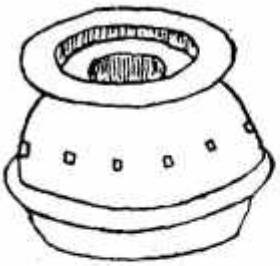


Fig. Compression shear spring

2. Compression-Shear Spring :

In this type, the road is carried partly by shear and partly by compression components in the rubber and hence; although large strains may be allowed in the rubber body, shear stress at the bonded faces is kept small and fatigue properties are excellent.

3. Steel-reinforced spring :

Fig. Steel reinforced spring

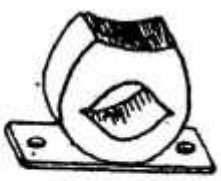
Steel reinforced spring ('Eligo's spring) consists of a steel helical spring bonded in a rubber body. The steel springing, though, carrying only about 20% of the load. Exercises a stabilizing influence on the rubber component thereby allowing a greater stroke/diameter ratio to be used without other forms of guiding.

4. Progressive spring :

It has initially an exceedingly small rate which rises rapidly as the central cavity closes.

5. Face shear spring :

It consists of a thick disc of rubber having metal plates bonded to its flat surfaces, and axially precompressed. It is crates by a relative rotation of the plates about its axis thus loading the rubber partly in shear.



Progressive spring.

Face shear spring.

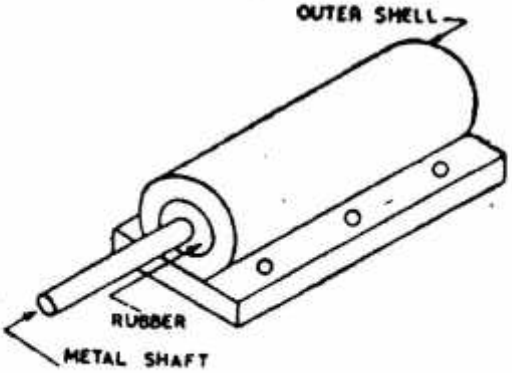
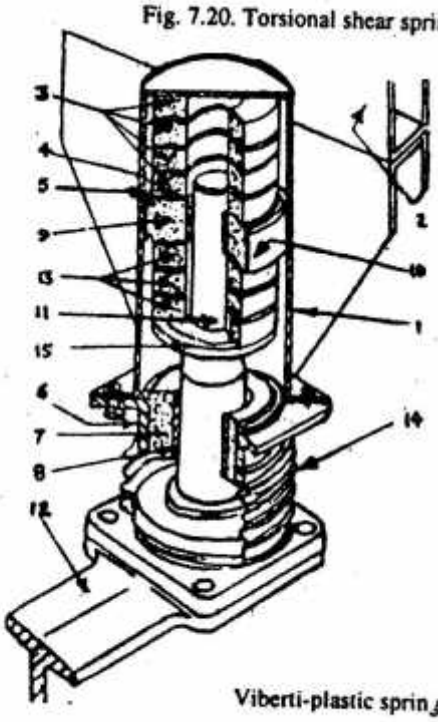


Fig. 7.20. Torsional shear spring.



Viberti-plastic spring.

Fig. Viberti-plastic spring

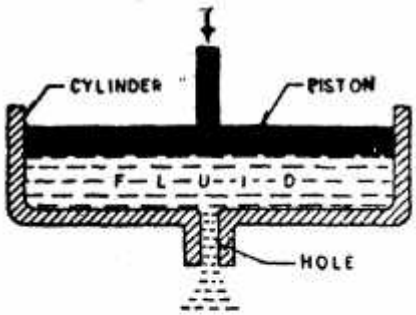
6. Torsional shear spring :

It consists of an inner metal shaft, tubular or solid, and an outer trough-like shell between which rubber body is bonded. The latter being put under pressure by closing the trough with a riveted or spot welded base plate. The spring operates by the rotation of the shaft about its own axis relative to the shell.

Shock Absorbers :

Introduction :

A springing device must be a compromise between flexibility and stiffness. It is more rigid, it will not absorb road shocks efficiently and if it is more flexible it will continue to vibrate even after the bumb has passed. So we must have sufficient damping of the spring to prevent excessive flexing.



The friction between the leaves of a leaf-spring provides this damping, but because of uncertain of the lubrication conditions, the amount of friction also varies and hence the damping characteristics do not remain constant. For this reason, the friction between the springs is reduced to minimum and additional damping is provided by mean of devices called dampers or shock-absorbers. In the case of coil springs, the whole of damping is provided by the shock absorbers. The shock-absorbers thus control the excessive spring vibrations.

In fact the name shock absorber is rather misleading since it is the spring and not the shock absorber that initially absorbs the shock. The 'shock absorber' absorbs the energy of shock converted into vertical movement of the axle by providing damping and dissipating the same into heat. Thus, it merely serves to control the amplitude and frequency of spring vibrations. It cannot support weight and has zero resilience. Therefore, 'damper' is a better term technically to describe the 'shock absorber.'

The shock absorbers are basically of two types- the friction type and the hydraulic type. The friction types has almost become obsolete due to its non-predictable damping characteristics. The principle of operation of a hydraulic shock absorber is that when a piston forces the fluid in a cylinder to pass through some hole (fig.), a high resistance to the movement of piston is developed, which provides the damping effect. The hydraulic type has the additional advantage that the damping is proportional to the square of the speed. So for small vibrations the damping is also small, while for larger ones the damping becomes automatically more. A telescopic type hydraulic shock absorber is explained here.

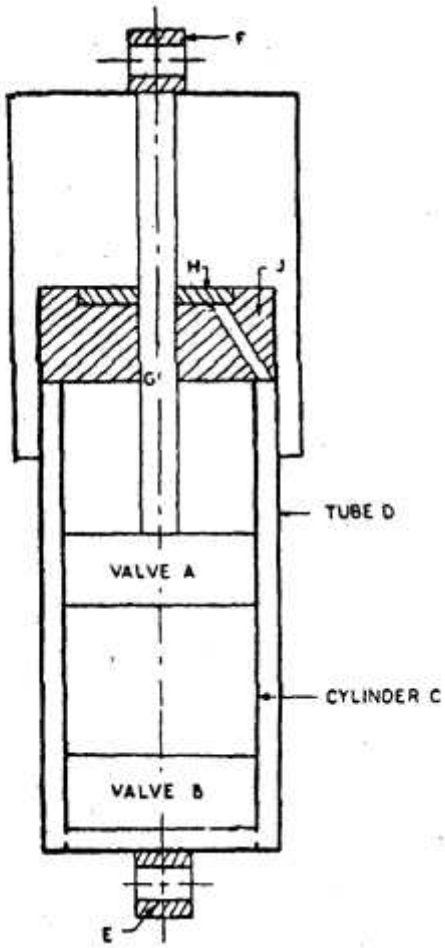


Fig. Telescopic type shock absorber

Telescopic Type Shock Absorber :

As shown is Fig. rod G is attached to the two way valve A, while another similar two-way valve B is attached at the lower space between cylinder C and tube D, which is connected to the space below the valve assembly B as shown. H is gland in the head J and any fluid scrapped off by rod G is brought down into the annular space through the inclined passage shown in the head. The eye E is connected to the axle, while the eye F is attached to the chassis frame. The fluid generally used in shock absorbers is a mixture of 60 percent transformation oil and 40 percent turbine oil.

To understand the action of the shock absorber, consider that the car has come across a bumb. Then eye

E would move up and thereby the fluid will .

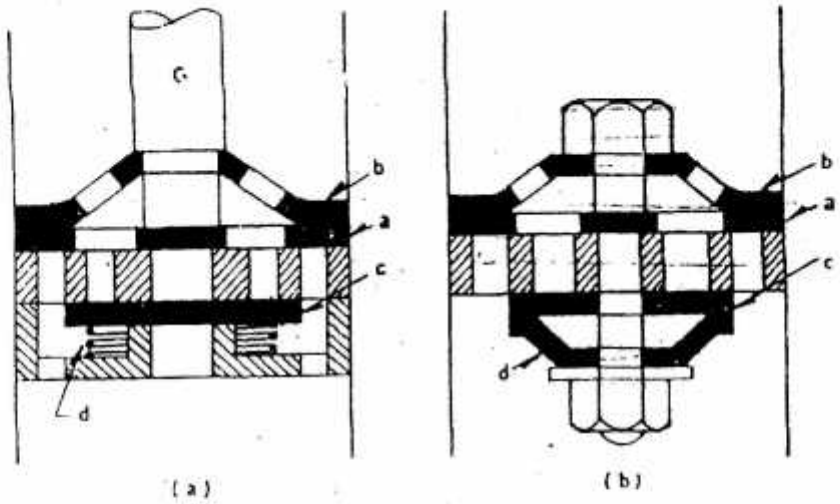


Fig. Details of valve assemblies

Q. 6. (a) What do you understand by 'Centre point steering' and wheel alignment?

Ans. Definition :

Combined angle or included angle is the angle fanned in the vertical plane between the Wheel centre line and the king pin centre line (or steering axis). Combined angle is equal to camber plus king pin inclination (or steering axis inclination).

In a rear-wheel drive vehicle, the tractive force of the vehicle pushes the suspension cross member and the body forwards during drive. Thus the forward tractive force acts at the point on the road where the steering axis or the king pin axis meets when projected. The road resistance acts at the wheel contact point on the road. The distance between these two points is called scrub radius. It is positive when the tyre centre line lies outside the steering axis Fig. It is negative when the tyre centre line is inside the steering axis. It is measured in mm. The amount of the scrub radius depends upon the steering axis inclination. The wheel offset and suspension height. In front wheel drive vehicle, the tractive force is imparted to the front wheels so that it acts forward through the wheel contact point on the road. Thus the effect is opposite immature to that in the rear-wheel drive described above.

Effect :

(i) Fig., shows the effect of combined angle variation on the scrub radius and hence on the forces acting to turn the wheel in case of a rear-wheel drive vehicle. It is seen that unless scrub radius is negative the wheel tends to toe-in fig. (a)

(ii) If the scrub radius is positive, the wheel tends to toe-out. fig. (c)

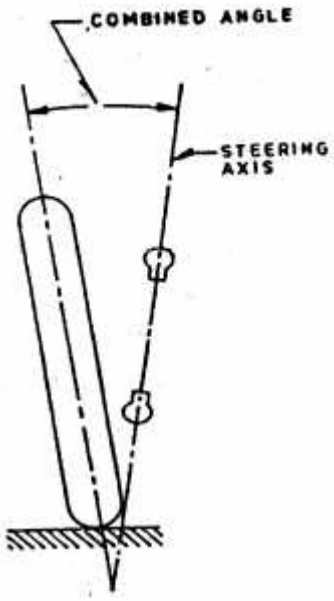


Fig. Combined Angle

(iii) If the scrub radius is zero the wheel keeps its straight position, without any tendency to toe-in or toe-out fig. (b) In this position the steering is called centre point steering. Previously the centre point steering was considered ideal to achieve, but now it has been proved by experience that best results are obtained in practice if the point of intersection of the wheel and the king pin centre lines is slightly below the ground. In case the centre point steering is adopted, any small change in the combined angle under variable running conditions will cause the point of intersection to move alternately above and below the ground, thus causing toe-in or toe-out, which will become a source of car wander. However, a large scrub radius will cause greater torque to be required to turn the wheel which means higher loads on the steering linkage and suspension components. This would result in greater wear of steering linkage. The effect of unequal braking on the front wheels would also be enhanced with a large scrub radius, which would make the driving dangerous.

If the included angle and hence the amount of toe-out is not equal on both the wheels, the vehicle will obviously have a tendency to pull towards the side having the larger scrub radius.

As the driving and handling sensations come from the road and the tyre, the scrub radius is the parameter to provide necessary road feel to the driver.

Amount : Combined angle may be 9–10 degrees and the scrub radius should be upto about 12 mm.

Wheel alignment : Positioning of the steered wheels to achieve the following is termed wheel alignment :

1. Directional stability during straight ahead position.
2. Perfect rolling condition on steering.
3. Recovery after completing the turn.

Factors of Wheel Alignment :

The term 'wheel alignment' is used in connection with the stability and control of the vehicle while in motion. Wheel alignment means that while moving straight ahead the wheels should be parallel. In the event they are pointing inward, they are said to toe in (Fig. 8.7 a), whereas if they are pointing outward they are said to toe-out fig. (b). Both these situations are undesirable because in either case while rolling forward, each heel will be simultaneously slipping laterally, due to which a continuous cross-tread scrubbing takes place. Examining such a tyre tread would reveal a diagonal wear pattern, with the leading side of the tread blocks heavily worn and the trailing side having a feather like appearance. Thus the result of net toe-in or toe-toe-out the wheels during running is excessive tread wear, heavy steering and also greater fuel consumption.

For good steering, handling and vehicle stability, it is also necessary that rear wheels should follow the front wheels properly. This condition occurs if all the four wheels are parallel to the frame. This is called tracking.

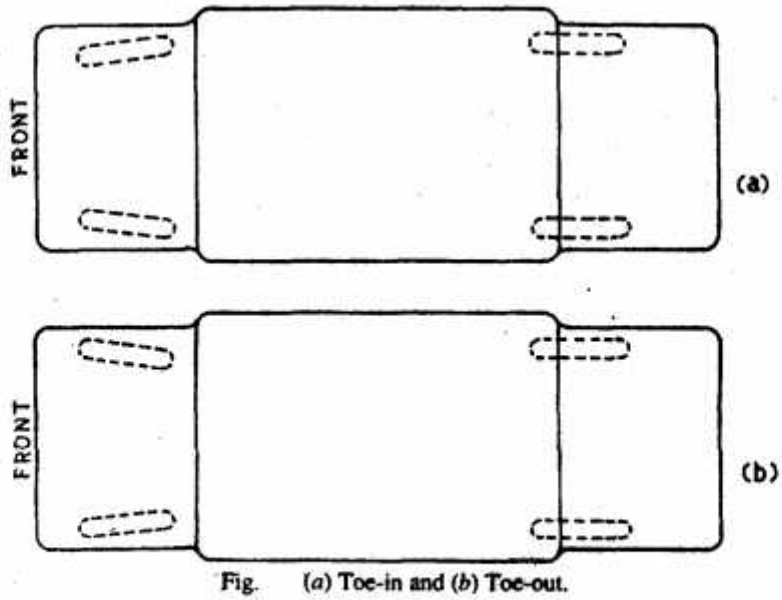


Fig. (*a*) Toe-in and (*b*) Toe-out.

To have effective steering under all conditions and at all loads, it is very important to consider and understand the factors which influence the stability and control of the vehicle. These factors are :

1. Factors pertaining to wheels.
2. Steering geometry.
3. Steering linkages.
4. Suspension system.

Out of these suspension system has already been described in the last chapter. While other factors are discussed in the following articles.

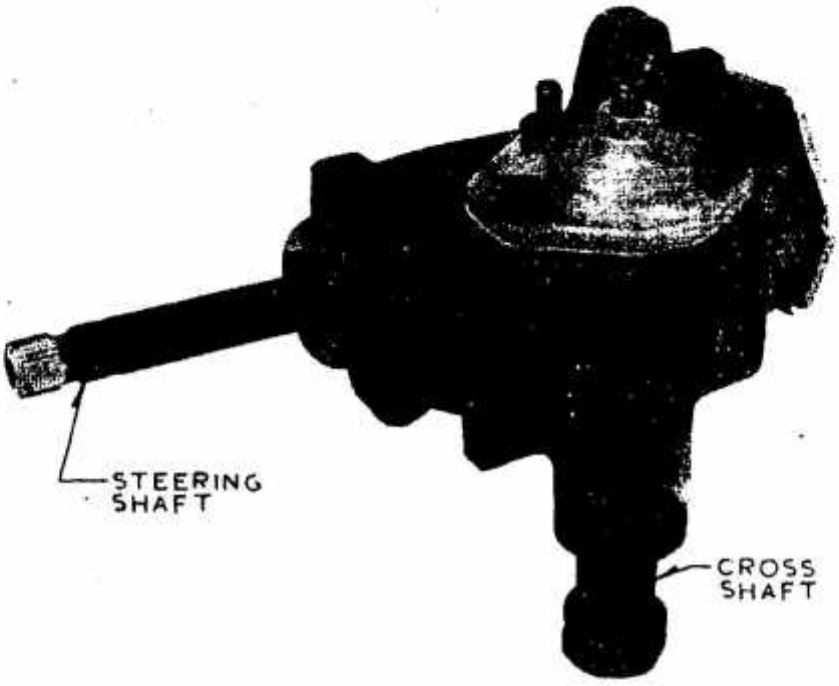
It may be noted that on frame type vehicles, two-wheel alignment is usually acceptable since the measurements are taken from the frame and it is assumed that rear axle is correctly aligned. However, in case of frameless vehicles with four-wheel independent suspension, there being no frame, the correct alignment of the rear wheels cannot be assumed. Therefore in such a case, four wheel alignment is necessary for proper steering and handling.

Q. 6. (b) What is the function of a steering gear? Describe in detail the rack and pinion type manual steering gear by means of a simple sketch and discuss its advantages.

Ans. Steering gears :

The steering gear convert the turning motion of the steering wheel into the to-an -for motion to the link rod of the steering linkage. Moreover, it also provides the necessary leverage so that the driver is able to steer the vehicle without fatigue.

There are many types and makes of steering gears in use for automobiles. However, only a few important ones out of them are discussed here. The working of the other types is also similar.



Rack and Pinion Steering Gear :

This type of steering gear is used on light vehicles like cars and in power steering. Maruti 800 cars employ this steering gear fig. It is simple, light and responsive. It occupies very small space and uses lesser number of linkage components compared to the worm and wheel type of gear.

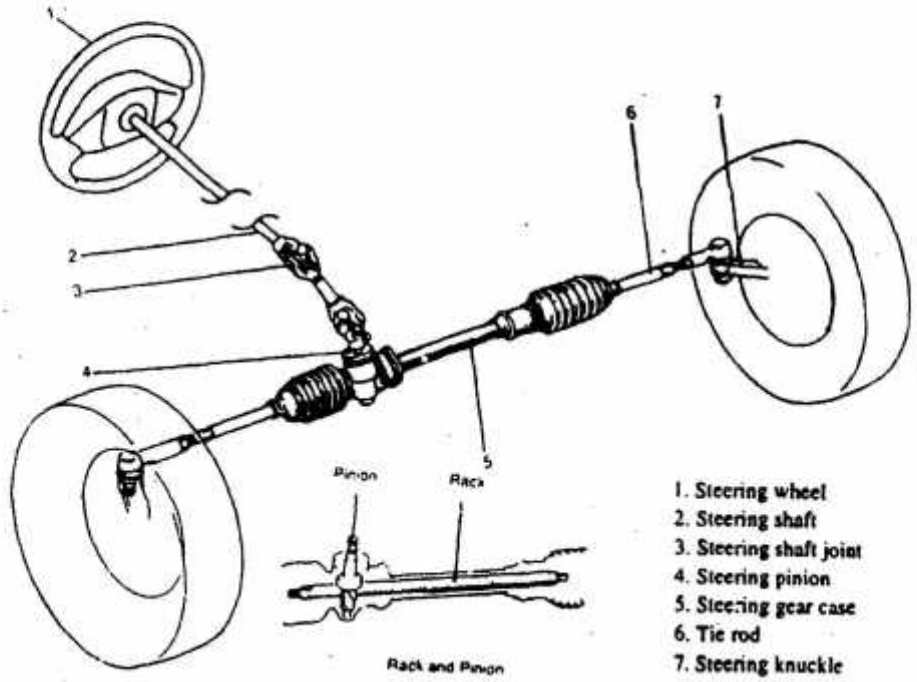
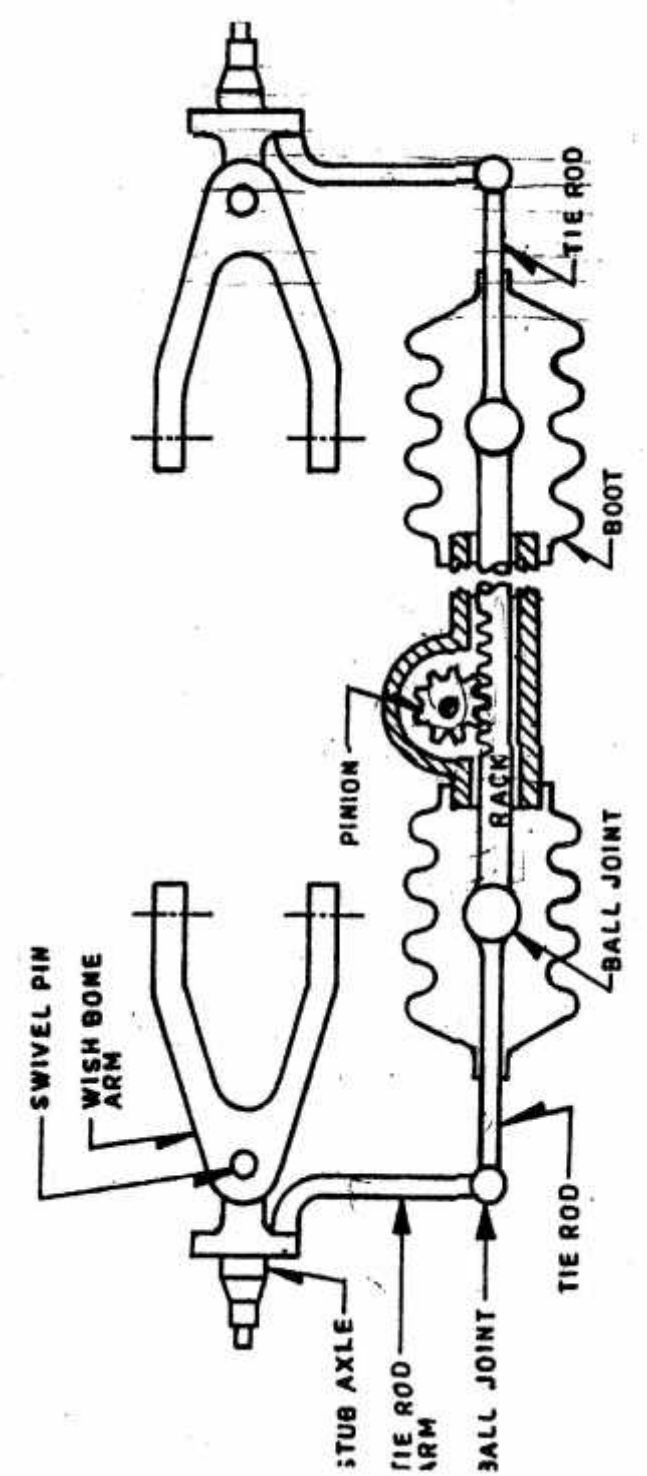


Fig. shows the rack and pinion type of steering gear (end take off type) along with its linkage. The rotary motion of the steering wheel is transmitted to the pinion of the steering gear through universal joints (not shown). The pinion is in mesh with a rack. The circular motion of the pinion is transferred into the linear rack movement, which is further relayed through the ball joints and tie rods to the stub axles for the wheels to be steered. Such a steering gear is shown at the bottom in Fig. Another design of this type of steering gear is shown at the top in Fig. in which the tie rods are connected at the centre of the rack instead of at the ends. This is called the centre take off rack. It has a large boot that covers the centre part of the rack and pinion housing. A slot in the housing permits the inner tie rod ends to move with the rack. This type, viz, the centre take off design can be mounted high, saving space and shortening the length of the steering column.

Compared with the end take off design, this is also affected less by bump steer. When the toe of wheels changes as they go over a bump or through a depression on the rod, the vehicle is said to have bump steer.


TIE ROD
BOOT
PINION
RACK
BALL JOINT
SWIVEL PIN
WISH BONE ARM
STUB AXLE
TIE ROD ARM
BALL JOINT
TIE ROD

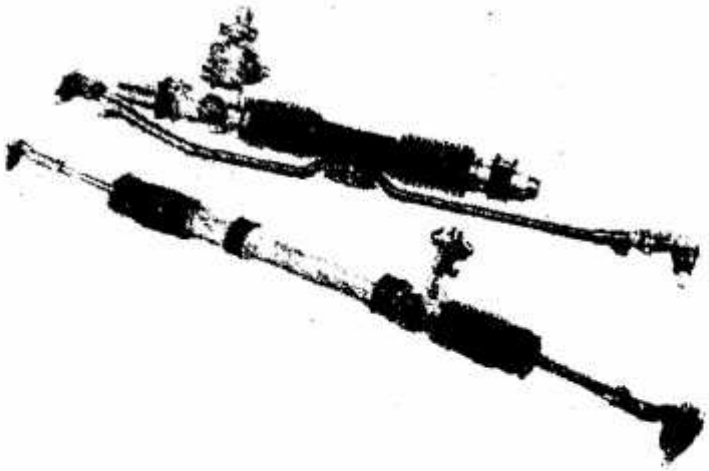


Fig. Saginaw Rack and pinion steering gears
- Top-centre take off, bottom-end take off

Q. 7. (a) Describe layout of a pneumatic brake system used on a bus, name the parts and explain the working.

Ans.

Theoretical analysis

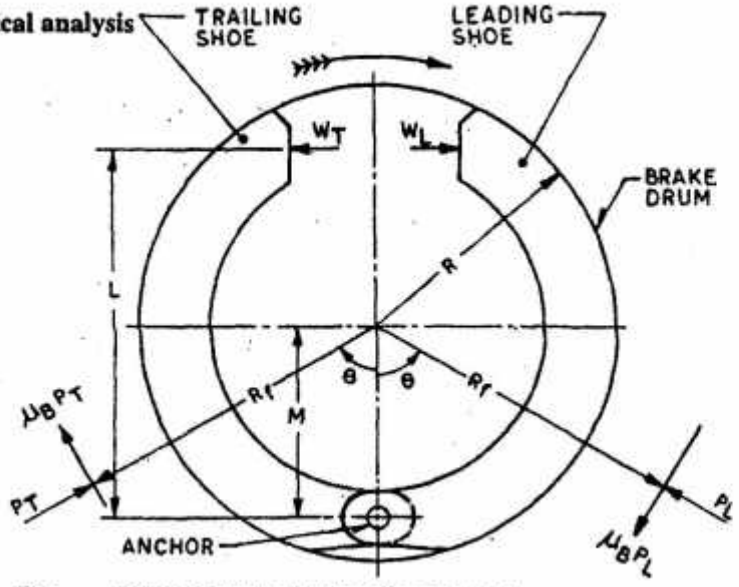


Fig. Forces in internally expanding shoe brake.

Let

W_L and W_T = Actuating force for leading and trailing shoe respectively.

R = Radius of brake drum

R_F = Effective radius of the friction force P_T or P_L.

θ = Angle between the line of action of the friction force and the line joining the centre of the brake drum to the anchor.

μ_B = Coefficient of friction between the brake lining and the drum.

P_L and P_T = Normal forces between shoe (lining) and the drum.

The magnitudes of P_L and P_T may be calculated by taking moments about the fulcrum (anchor). Considering separately the equilibrium of the leading and the trailing shoes :

For leading shoe,

$$W_L \times L - P_L . M \sin\theta + \mu_\beta P_L (R_f - M\cos\theta) = 0$$

$$\therefore \quad P_L = \frac{W_L . L}{M\sin\theta - \mu_B (R_f - M\cos\theta)}$$

$\therefore$ Braking torque, T_L

$$\mu_B P_L \times R_f$$

$$= \frac{W_L . L . \mu_B . R_f}{M\sin\theta - \mu_B (R_f - M\cos\theta)}$$

For tailing shoe,

$$W_T \times L - P_T . M \sin\theta - \mu_B P_T (R_f - M\cos\theta)$$

$$\therefore \quad P_T = \frac{W_T . L}{M\sin\theta + \mu_B (R_f - M\cos\theta)}$$

Braking torque, T_T,

$$= \mu_B P_T \times R_f$$

$$= \frac{W_T . L . M_B R_f}{M\sin\theta + \mu_B (R_f - M\cos\theta)}$$

If the forces on two shoes are equal,

$$W_L = W_T = W$$

Further if $\theta = 90°$, the equations (i) and (ii) can be simplified as,

$$T_L = \frac{W . L\mu_B . R_f}{M - \mu_B . R_f}$$

$$T_T = \frac{W . L\mu_B . R_f}{M + \mu_B R_f}$$

Since denominator in equation will always be greater than the denominator in equation, T_L will always be greater than T_T.

Q. 7. (b) Give detailed account of a type specification. How do the designation of radial and non-radial types differ from each other?

Ans. Types of brakes :

The brakes for automotive use may be classified according the following considerations :

1. Purpose
2. Location
3. Construction
4. Method of actuation
5. Extra braking effort

Purpose :

From this point of view the brakes may be classified as the service or the primary and the parking or the secondary brakes. The service brakes are the main brakes used for stopping the vehicle while in motion, whereas the parking brakes are meant of hold the vehicle on a slope.

Location :

The brakes may be located either at the transmission or at the wheels. The wheel brakes are definitely better from heat dissipation point of view on account of two reasons. Firstly the location of transmission brakes from this view point is very poor and secondly only one brake drum; whereas in case of wheel brakes we may have four brake drums i.e. one on each wheel which increases the area available for heat dissipation. Further as in case of transmission brakes the whole of the braking torque has to be transmitted through the universal joints, propeller shaft, differential and the rear axle, suitable provision must be made in their design and their sizes increased proportionally. However, if the brakes are located on the transmission, the braking torque is equally divided automatically by the differential between the two wheels and no special compensation is needed. Further because of the reduction at the differential, the transmission brakes would be stronger than the brakes of similar capacity at the wheels.

In case of automobiles, the wheel brakes are used universally.

Construction :

From construction point of view, two categories are the drum brakes and the disc brakes. These have been explained in detail in Art 8 and 9.

Method of actuation :

This criterion gives the following brake types :

(a) Mechanical brakes.

(b) Hydraulic brakes.

(c) Electric brakes.

(d) Vacuum brakes.

(e) Air brakes.

These will be described in detail in the later sections.

Extra braking effort :

When the weight of the vehicle is more, so that the driver cannot apply the brakes comfortably without fatigue his effort is supplemented with some source of energy which makes the application of brakes easier. If this outside help, which may be taken from the transmission of the vehicle itself, only partly helps the driver, who also has to apply some effort, the brakes are called servo brakes or power-assisted brakes. However, when practically none of the braking effort is applied by the driver, the brakes are termed power brakes or power-operated brakes, Both these types will be later studied in detail.

Q. 8. (a) What are the pollutants emitted by an automobile? Discuss the pollution control techniques used in practice.

Ans. What kinds of pollutants are emitted from auto body shops?

Auto body shops emit pollutants such as hazardous air pollutants (HAPs), particle pollution (dust), and volatile organic compounds (VOC). These pollutants can contribute to health problems that may affect shop employees, customers, and the community. While Federal, state, local, and Tribal regulations limit the amount of emissions from auto body shops, dangerous releases of HAPs can occur if an auto body shop does not operate in compliance with regulations.

• Paints, cleaners, and paint strippers can release some HAPs and VOC. Chemicals in these substances can also react in the air to form ground-level ozone (smog), which has been linked to a number of respiratory effects. EPA has developed a Web site on ground-level ozone.

• Lead, chromium and cadmium are metals that form particle pollution during sanding and welding. EPA's Air Toxics Health Effects Notebook has more information on lead, chromium, and cadmium.

• Breathing particle pollution can cause respiratory problems and other harmful health effects. EPA has developed a Web site on particle pollution.

• Diisocyanates are hazardous air pollutants emitted during painting operations.

These compounds are a leading cause of occupational asthma.

For more information on the toxicity of these pollutants, check out information on the Integrated Risk Information System (IRIS). EPA also has more information available at its Air Toxics Web site.

How can I help auto body shops reduce air pollution?

• **Make Connections :**

• Get to know local auto body shop owners and operators. They know best about the materials and processes used in their business and the regulations with which they must comply.

• *Keep local media aware of progress by sending them updates. Publicity can reward success and attract* more public involvement.

• **Make a Plan :**

• One idea is to form a work group that includes local owners and operators to develop and implement workable pollution reduction plans.

• **Locate Resources :**

• Find state, local, and Tribal contacts.

• *Use the resources listed on these Web pages to get help with analysis, technical information, equip-*ment, and funding.

- **Sponsor Training :**

- Improved skills lead to reduced paint usage and exposure for workers.

- Small shops may need funding in order to attend or provide training.

- **Reward Facilities :**

- Use media connections to provide coverage for successful efforts. Positive publicity can mean increased business.

- *Visibly displayed awards or certificates; may also increase business.*

- Check out the award, EcoBiz Auto Repair Shops in the Portland Area (PDF) (2 pp, 48 KB), from Oregon Department of Environmental. Quality offered to auto body shop owners and operators practicing pollution prevention.

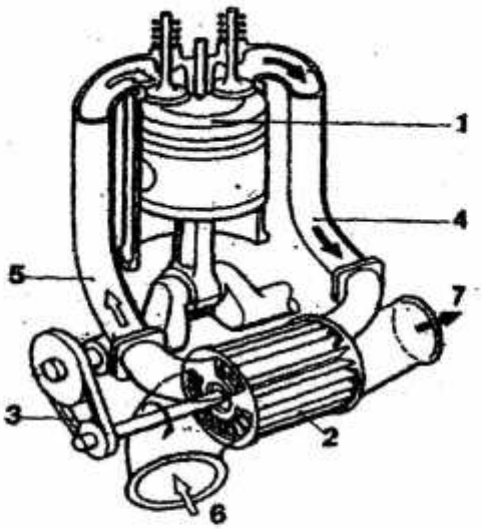
- **Be an Informed Consumer :**

- Patronize shops that implement pollution prevention strategies. Check with your insurance company to see if they know of shops that practice pollution prevention.

Q. 8. (b) Discuss the purpose and operation of charging system used in an automobile.

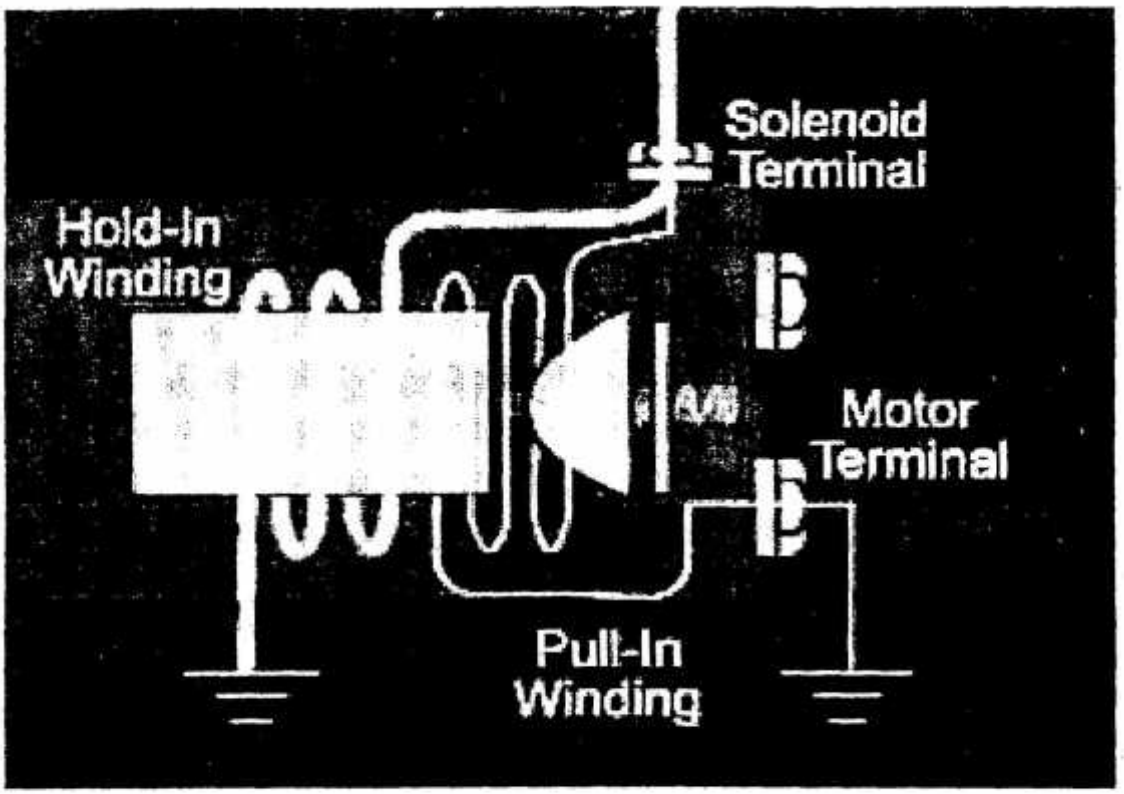
Ans. Automotive vehicles include a storage battery for operating electronics in the vehicle and using an electric starter to start the vehicle engine. Automotive batteries provide power for the vehicle's starting, lighting and ignition (SLI) components of the car. The rechargeable battery provides cranking power to start the vehicle and also is the only source of power to continue to maintain the lights or other devices in operation when the vehicle ignition has been turned off. When the vehicle is running, the engine is used to charge the battery. Additionally, the battery is also used to power electrical components of the vehicle when the engine is running. Automotive battery terminals typically comprise a conical contact section for mounting to a conical battery post terminal, and having a clamping mechanism for tightening the contact

section to the battery terminal, the terminal further comprising a conductor connection section. A battery charging system is coupled to the engine and is powered by the engine when the vehicle is running. The charging system is used to charge the storage battery when the vehicle is operating. Typical charging systems include a simple voltage regulator connected to the output of an alternator. The voltage regulator is used to set a voltage generated by the alternator which is applied to the battery. Voltage regulator controlled car battery charging systems keep an automotive storage battery at full charge level and to provide sufficient electrical power for the operation of the various automobile electrical accessories.



Translation Auto Care Center is the leader in Missoula for the service and repair of auto chargings systems. Our Missoula auto shop staff take the time to educate our customers in knowing that the battery, starting and charging systems in their car or truck play pivotal roles in ensuring the dependable operation of your vehicle while driving in and around Missoula. The car battery stores electrical energy that is then converted by the starter into the mechanical force necessary to start your engine. The alternator then serves the purpose of producing the electrical current–initially provided by the car battery–that is necessary for the vehicle's electrical needs when the engine is running. The ignition module turns the low voltage supply to the ignition coil on and off, which in turn is converted to a higher voltage that is necessary for the vehicle's ignition system to operate. The voltage is used to engage the spark plugs and create the sparks that are necessary to ignite the combined air/fuel mixture in the car engines cylinders. It is this ignition that is ultimately used to power the pistons that in turn begin the rest of the process of powering your car or truck.

There are various factors that contribute to the wear and tear of your vehicle's battery, charging and starting systems. For example the frequent turning on and off of your automobile when running errands in Missoula will cause more wear and tear than a daily commute to and from your Missoula workplace. Other factors that affect the wear and tear of the battery, charging, and starting system include Missoula driving and weather conditions, overall mileage, vehicle age, and various automotive components like in vehicle entertainment systems that cause an excessive electrical draw.



The symptoms you may experience that indicate possible problems with your battery, charging, and starting systems include the dimming of headlights and interior lights, the "check engine" and/or battery light coming on, or the failure of various car or truck accessories.

The mechanics at our Missoula auto repair shop are expertly trained in the complete service and repair of car and truck batteries, charging, and starting systems. If you think you are having problems with any of the components of your charging and starting system bring your car or truck to our Missoula automotive repair service center and let us.